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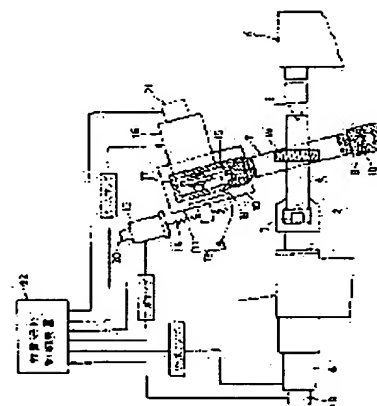
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(54) FINISHING METHOD FOR GEAR

(57)Abstract:

PURPOSE: To eliminate fluctuation of machining accuracy and improve machining accuracy in stable state by correcting the position of a grinding wheel according to the backlash detected by a sensor in the meshing condition of a gear to be worked with the grinding wheel.

CONSTITUTION: When reference positions of a work W and a grinding wheel 7 are calculated, the reverse rotation command per one pulse is given to a main spindle motor 6 so as to intermittently reversely rotate the work W by a minute quantity. When following rotation of the grinding wheel 7 is begun, rotation of the work W is stopped, and rotating displacement during the time of the work W is counted as the number of pulse generated in a pulse generator 19. This rotating displacement corresponds to the backlash between the work W and the grinding wheel 7. Next, when the calculated value of backlash is obtained, a position correcting quantity of a grinding wheel table 12 necessary to make the backlash zero, namely a necessary approaching quantity of the grinding wheel 7 to the work W hereafter is searched, and the control system of a feed motor 13 is commanded to approach the grinding wheel 7 to the work W by the position correcting quantity to appropriately mesh with each other.



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TITLE OF THE INVENTION

A finishing method of gear
[Claims for the Patent]

(1)

In a finishing method for finishing a gear to be processed, which comprises the following steps:

- a step that center impeller supports the gear which should be processed with head-stock comprising a spindle motor and tail stock,

- a step which it is supported by a wheel-spindle stock, and rotationally drive a gear-shaped abrasive wheel by means of an abrasive wheel drive motor,

- a step which gives a wheel-spindle stock feed by feed motor by it synchronizes by engaging a wheel-spindle stock with gear to be processed, and turning and, the finishing method of gear characterized by the following processes:

- a process which by quantity of turns intermittently minute in gear to be processed in the condition which engaged an abrasive wheel with gear to be processed before a work by a spindle motor,

- a process calculating the reamer reference position which it is, and an abrasive wheel turns around with a revolution of gear to be processed, and begin to do,

- a process making gear to be processed reverse by a minute amount from a reamer reference position by means of a spindle motor intermittently,

- a process detecting revolution displacement magnitude of gear to be processed before it is again, and an abrasive wheel turns around from said reamer reference position, and beginning to do with a sensor,

- a process which above revolution displacement magnitude is based on, and calculate position augments of the abrasive wheel that it is necessary to do gear to be processed and backlash between things of an abrasive wheel in a zero,

- a process which gear to be processed and backlash between things of an abrasive wheel are based on above position augments so that it is in a zero, and feed is given a wheel-spindle stock by feed motor, and revise a position of an abrasive wheel.

DETAILED DESCRIPTION OF THE INVENTION

FIELD OF INDUSTRIAL APPLICATION:

The present invention relates to a finishing method of gear by grinding.

PRIOR ART:

Face roughness of spur gear and tooth flank of a hasu both teeth wheel and improvement of tooth form accuracy are aimed for, and that finishing of gear is put is conducted by grinding.

Finishing by such a grinding makes, for example, support center impeller with head-stock and tail stock in gear to be processed, it makes do an each synchronous rotation with an abrasive wheel drive motor with an abrasive wheel by a spindle motor in gear to be processed while this cover work gear and an abrasive wheel of form of internal gear can be engaged, what is ground using sliding contact between gear to be processed and tooth flank with an abrasive wheel by turning gear to be processed and abrasive wheel like gear set is done with a base.

A problem to be solved by the invention

In such a conventional finishing method, it is an ideal that gear to be processed and abrasive wheel can be engaged so that the backlash becomes a zero, and conduct a

work.

However, after having matched a phase with an abrasive wheel with gear to be processed, even if prescribed feed was given a wheel-spindle stock for the purpose of it being, and gear to be processed and center-distance with an abrasive wheel were able to engage both parties with prescribed value, a fighting each other condition of the both parties may not become always given.

This is so that a work error at the time of the cutting that individual gear has and an abrasion condition of an abrasive wheel delicately influence, and in this situation improvement of accuracy of finishing cannot be expected.

Because of this after it was unavoidable, and an operator brought gear to be processed and abrasive wheel close slowly, and, in the event of the gear which high accuracy was demanded from, having been able to engage both parties, normal and reverse rotations can put gear to be processed or an abrasive wheel, and a fighting each other condition of both parties is confirmed.

However, as for the activity, the place that is due to experience and perception is big, dispersion is easy to be produced by an individual operator to be able to ache, a problem is still had on a thing of equalization of gear cutting accuracy.

Further because gear to be processed and coming together activity itself with an abrasive wheel are hand work, when all automation of gear cutting is propelled, it is with big trouble.

The present invention was finished in view of problems such as the above.

gear to be processed and backlash between things of an abrasive wheel are grasped quantitatively, and there is for the purpose of the backlash providing the reasonable method that it is engaged, and was able to create a condition automatically how it is in a zero.

MEANS FOR SOLVING PROBLEM:

Including the process that the present invention is the following:

a step that center impeller supports gear to be processed with head-stock comprising a spindle motor and tail stock,

a step which it is supported by a wheel-spindle stock, and rotationally drive a gear-shaped abrasive wheel with an abrasive wheel drive motor,

a step which makes both parties is engaged by means of giving a wheel-spindle stock feed by feed motor, and do a synchronous rotation,

the finishing method of the gear which made finishing on gear to be processed,

the finishing method of gear characterized by means of the following processes:

a process which by quantity of turns intermittently minute in gear to be processed in the condition which engaged an abrasive wheel with gear to be processed before a work by a spindle motor,

a process which calculates the reamer reference position which it is, and an abrasive wheel turns around with a revolution of gear to be processed, and begin to do,

a process which makes gear to be processed reverse by a minute amount from a reamer reference position by a spindle motor intermittently,

a process which detects revolution displacement magnitude of gear to be processed before it is again, and an abrasive wheel turns around from the reamer reference position, and beginning to do with a sensor,

a process which the revolution displacement magnitude is based on, and calculate

position augments of the abrasive wheel that it is necessary to do gear to be processed and backlash between things of an abrasive wheel in a zero,

a gear to be processed and a backlash between things of an abrasive wheel become a zero, it is the step which the position augments is based on, and feed is given a wheel-spindle stock by feed motor, and revise a position of an abrasive wheel.

Operation

According to this method, gear to be processed and a real backlash between things of an abrasive wheel are detected, gear to be processed and a backlash between things of an abrasive wheel become a zero at a stage to begin finishing by this backlash is accepted, and revising a position of an abrasive wheel, and the fighting each other condition which is appropriateness according to an ideal is provided.

Example

FIG. 2 - FIG. 4 is an architecture explanatory drawing representing an example of the finishing device which the present invention is applied to.

When, as for cover work gear (for purposes of this example, it is shown to that example of a hasu both teeth wheel, a the following work-piece is feigned) W comprising shank S, is supported the one end in chuck 2 of head-stock 1 side and head center 3, and, as shown in FIG. 2, is supported other edge in tail center 5 of four tail stock sides, is rotationally driven by spindle motor 6.

Circumferentially internal gear engaging with this work-piece W-shaped abrasive wheel 7 of work-piece W, is arranged in form supported to abrasive wheel electrode holder 8, abrasive wheel electrode holder 8 goes through axle box baring 10 to housing 9 as shown in FIG. 3 and FIG. 4, and is supported rotatably.

Housing 9 is coupled to sliding base 11 by one body, and wheel-spindle stock 12 is comprised with sliding base 11.

And feed is given by feed motor 13 and ball screw 14, and, as for wheel-spindle stock 12, advance go-astern comes to work.

Chain 18 is about to be wound up between chain sprocket 15 of eight abrasive wheel electrode holder sides and chain sprocket 17 of 16 abrasive wheel drive motor sides while chain sprocket 15 is formed in circumference of abrasive wheel electrode holder 8 by one body, and abrasive wheel 7 goes through chain 18 with abrasive wheel drive motor 16, and it is rotationally driven.

Thus, after having engaged abrasive wheel 7 with work-piece W, because an each synchronous rotation can put abrasive wheel 7 with abrasive wheel drive motor 16 by spindle motor 6, work-piece W and abrasive wheel 7 do work-piece W like a relationship of gear set, and it rotates, grinding finishing is put for tooth flank of a work-piece W side for sliding contact between tooth flank of both parties.

In addition, spindle motor 6, feed motor 13 and abrasive wheel drive motor 16 has pulse generator 19, 20 or 21 as a position sensor in each, each pulse generator 19, 20, 21 form a position feedback control loop between location control equipment 22.

Axle box baring electrode holder 23 is gone through as shown in FIG. 3 and FIG. 4 to a side of abrasive wheel electrode holder 8, and magnet 24 is assembled, magnetic sensor 25 actuating magnet 24 as a to be detected thing to the other, housing 9 goes through bracket 26, and is assembled.

When this magnetic sensor 25 faces magnet 24, when, using the property that magnetic field changes into in the case that is not so, abrasive wheel 7 is calculated

in prescribed constant angle stopping place with a thing outputting the magnetic field change as a change of current value, is used.

As thus described a step shown in a flow chart of FIG. 1 is depended on when a finishing device composed of is used, and a work is conducted.

Abrasive wheel 7 is turned with abrasive wheel drive motor 16 while work-piece W is turned by spindle motor 6, and a gear tooth of work-piece W calculates as shown in FIG. 1 and FIG. 2 for the purpose of it being in a prescribed phase, and a gear tooth of abrasive wheel 7 is calculated so that a phase of a gear tooth of a work-piece W side and a phase of a gear tooth of seven abrasive wheel sides agree.

As for this, a gear tooth of abrasive wheel 7 is calculated by stopping a revolution of abrasive wheel drive motor 16 in FIG. 3 and the position that magnetic sensor 25 faced magnet 24 as shown in FIG. 4.

If work-piece W and indexing of abrasive wheel 7 were completed, feed motor 13 is operated, and feed is given wheel-spindle stock 12, only specified quantity advances wheel-spindle stock 12 by quick traverse.

The stroke that should advance wheel-spindle stock 12 is set beforehand, because, besides, a phase with abrasive wheel 7 has already agreed with work-piece W as discussed above, work-piece W and abrasive wheel 7 will be engaged in a rough condition hereby.

A revolution command every one pulse is given as against spindle motor 6 successively, and by pettiness amount turns work-piece W intermittently, till abrasive wheel 7 begins to rotate by this action, it is continued.

In other words, Till, at the same time, it is, and abrasive wheel 7 turns around, and it begins to be done for a revolution of work-piece W, work-piece W is turned intermittently, a revolution of work-piece W is stopped in the point that abrasive wheel 7 is, and it turns around, and have begun to be done.

Here, Because magnetic sensor 25 detects this promptly when little, magnet 24 facing magnetic sensor 25 beforehand moves, it can confirm whether it is, and abrasive wheel 7 turns around, and it has begun to be done.

The condition which work-piece W and one tooth flank Fa of abrasive wheel 7, Fb touched to represent to FIG. 5 is created by the above, this position becomes a reamer reference position.

If a reamer reference position was calculated, it makes a reverse rotation command every one pulse is given as against spindle motor 6 this time, and work-piece W reverse by a pettiness amount intermittently.

And, Till, at the same time, it is, and abrasive wheel 7 turns around, and it begins to be done in reverse rotation of work-piece W, it makes work-piece W reverse, pulse generator 19 of six spindle motor sides counts revolution displacement magnitude of work-piece W in the meantime as occurring pulse number P while a revolution of work-piece W is stopped in the point that abrasive wheel 7 is, and it turns around, and have begun to be done.

This revolution displacement magnitude is equivalent to work-piece W and backlash amount ΔC (FIG. 5) between things of abrasive wheel 7.

In addition, It is detected whether it is, and abrasive wheel 7 turns around, and it has begun to be done with magnetic sensor 25 same as the above.

If revolution displacement magnitude of work-piece W was provided as pulse number P1, backlash amount ΔC is calculated by the next formula.

Total indexing pulse number, D_p when a one revolution was able to place work-piece W are work-piece pitch diameter, and, $AC = (ff DP/PC) XPI$ here, P_c is both known value.

As discussed above, If value of backlash amount ΔC was found, grinding this backlash amount ΔC in a zero is demanded whether only which more should bring abrasive wheel 7 close to work-piece W in necessary position augments ΔZ of wheel-spindle stock 12 namely a condition of FIG. 5 from by the next formula.

It is $\tan \alpha$ to eight $\Delta Z C$ In addition, α is known value in pressure angle. Further, The a series of operations are conducted in arithmetic processing part in locating control equipment 22.

If position augments ΔZ of wheel-spindle stock 12 was pursued, this position augments ΔZ is applied to a control system of feed motor 13, and position augments ΔZ cook abrasive wheel 7, and further work-piece W can be approached.

By this, Work-piece W and backlash ΔC between things of abrasive wheel 7 become a zero, it is engaged, and a backlash is in a reasonable condition with work-piece W and abrasive wheel 7.

It is awarded a work trigger command from locating control equipment 22 after this, and spindle motor 6 and abrasive wheel drive motor 16 actuates, work-piece W and abrasive wheel 7 seem to be gear set, and finishing by grinding is put for iko in what a synchronous rotation does same as before.

After it, finishing by grinding is put by abrasive wheel 7 totally synchronizes with work-piece W like gear set same as before, and rotating.

In addition, It is not necessary for compulsion to always turn work-piece W with spindle motor 6 in the case of grinding.

EFFECT OF THE INVENTION:

According to the present invention, normal and reverse rotations can put to be processed gear by a spindle motor in the condition which was able to engage an abrasive wheel with to be processed gear before work start-off as above.

After having detected a backlash at that time with a sensor, it is composed of to revise a position of an abrasive wheel depending on the backlash amount.

Therefore backlash amount can be grasped quantitatively in comparison with before.

Even in the case of the gear which a high accuracy is demanded from, dispersion of accuracy of finishing is lost thereby,

And it is matched with improvement of accuracy of finishing itself, and stabilization of accuracy of finishing can be planned.

Further while it participates, it will not be necessary an operator, and, by means of that backlash amount can be grasped quantitatively as above, maintaining accuracy of finishing of gear for identification of backlash amount, complete automation of gear cutting can be realized.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is a flow chart representing one embodiment of the invention, and FIG. 2 is an architecture explanatory drawing representing an example of the finishing device which the present invention is applied to, and FIG. 3 is enlarged sectional view of a wheel-spindle stock of FIG. 2, and FIG. 4 is a right side surface explanatory drawing of FIG. 3, and FIG. 5 is the gear to be processed and explanatory drawing which it is engaged, and represent a condition with an abrasive wheel.

1.. head-stock,
3... head center,
4... tail stock,
5... tailing in flotation center,
6... spindle motors,
7.. abrasive wheels,
12... wheel-spindle stocks,
13... feed motor,
16... abrasive wheel drive motors,
19.. pulse generators (a sensor),
25... magnetic sensor,
W ... cover work gear,
A bC ... bank rush.

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明 細 書

1. 発明の名称

歯車の仕上加工方法

2. 特許請求の範囲

(1) 主軸モータを備えたヘッドストックとテールストックとで両持ち支持される被加工歯車と、砥石台に支持されて砥石駆動モータにより回転駆動される歯車状の砥石とを、送りモータにより砥石台に送りを与えることで噛み合わせた上で両者を同期回転させることにより被加工歯車に仕上加工を施すようにした歯車の仕上加工方法において、

加工に先立って、被加工歯車と砥石とを噛み合わせた状態で主軸モータにより被加工歯車を微小量ずつ間欠的に回転させて、被加工歯車の回転に伴って砥石が連れ回りし始める基準位置を割り出す一方、主軸モータにより被加工歯車を基準位置から微小量ずつ間欠的に逆転させて、前記基準位置から砥石が再び連れ回りし始めるまでの被加工歯車の回転変位量をセンサにより検出する工程と、被加工歯車と砥石との間のバックラッシュを零

にするのに必要な砥石の位置補正量を前記回転変位量に基づいて算出する工程と、

被加工歯車と砥石との間のバックラッシュが零になるように、前記位置補正量に基づいて送りモータにより砥石台に送りを与えて砥石の位置を補正する工程、

とを含むことを特徴とする歯車の仕上加工方法。

3. 発明の詳細な説明

産業上の利用分野

本発明は研削による歯車の仕上加工方法に関する。

従来の技術

平歯車やはす歯歯車の歯面の面粗度および歯形精度の向上を目的として、研削により歯車の仕上加工を施すことが行われる。このような研削による仕上加工は、例えば被加工歯車をヘッドストックとテールストックとで両持ち支持させ、この被加工歯車と内歯車状の砥石とを噛み合わせる一方、被加工歯車を主軸モータにより、砥石を砥石駆動モータによりそれぞれ同期回転させ、被加工歯車

と砥石とをあたかも歯車対のように回転させることによって、被加工歯車と砥石との歯面同士のすべり接触を利用して研削することを基本とする。

発明が解決しようとする課題

このような従来の仕上加工方法においては、被加工歯車と砥石とをそのバックラッシュが零になるように噛み合わせて加工を行うのが理想であるが、被加工歯車と砥石との位相を合わせた上で、被加工歯車と砥石との中心間距離が所定の値となるように砥石台に所定の送りを与えて両者を噛み合わせたとしてもその両者の噛み合い状態が常に一定になるとはかぎらない。

これは、個々の歯車がもつ機械加工時の加工誤差や砥石の摩耗状態が微妙に影響してくるため、このままでは加工精度の向上が望めない。

このようなことから、高精度が要求される歯車の場合には、やむを得ず作業者が被加工歯車と砥石とを徐々に近付けて両者を噛み合わせた上で、被加工歯車もしくは砥石を正逆転させて両者の噛み合い状態を確認するようにしている。

仕上加工を施すようにした歯車の仕上加工方法において、加工に先立って被加工歯車と砥石とを噛み合わせた状態で主軸モータにより被加工歯車を微小量ずつ間欠的に回転させて、被加工歯車の回転に伴って砥石が連れ回りし始める基準位置を割り出す一方、主軸モータにより被加工歯車を基準位置から微小量ずつ間欠的に逆転させて、前記基準位置から砥石が再び連れ回りし始めるまでの被加工歯車の回転変位量をセンサにより検出する工程と、被加工歯車と砥石との間のバックラッシュを零にするのに必要な砥石の位置補正量を前記回転変位量に基づいて算出する工程と、被加工歯車と砥石との間のバックラッシュが零になるように、前記位置補正量に基づいて送りモータにより砥石台に送りを与えて砥石の位置を補正する工程とを含んでいる。

作用

この方法によると、被加工歯車と砥石との間の実際のバックラッシュを検出した上で、このバックラッシュに応じて砥石の位置を補正することに

しかしながら、上記の作業は経験と勘に負うところが大きいために個々の作業員によってばらつきが生じやすく、歯車加工精度の均一化の上でも問題を残している。また、被加工歯車と砥石との噛み合わせ作業そのものが手作業であるために歯車加工の全自動化を推進する上で大きな障害となっている。

本発明は以上のような問題点に鑑みてなされたもので、その目的とするところは、被加工歯車と砥石との間のバックラッシュを定量的に把握して、そのバックラッシュが零になるような適正な噛み合い状態を自動的につくり出すことができるようにした方法を提供することにある。

課題を解決するための手段

本発明は、主軸モータを備えたヘッドストックとテールストックとで両持ち支持される被加工歯車と、砥石台に支持されて砥石駆動モータにより回転駆動される歯車状の砥石とを、送りモータにより砥石台に送りを与えることで噛み合わせた上で両者を同期回転させることにより被加工歯車に

より、仕上加工を開始する段階では被加工歯車と砥石との間のバックラッシュが零となって理想通りの適正な噛み合い状態が得られる。

実施例

第2図～第4図は本発明が適用される仕上加工装置の一例を示す構成説明図である。

第2図に示すように、軸部Sを備えた被加工歯車（この実施例でははす歯歯車の例を示しており、以下ワークと称する）Wは、その一端をヘッドストック1側のチャック2とヘッドセンタ3とで支持されるとともに他端をテールストック4側のテールセンタ5で支持された上で主軸モータ6によって回転駆動される。

ワークWの外周には、このワークWと噛み合う内歯車状の砥石7が砥石ホルダ8に支持されるかたちで配設されており、砥石ホルダ8は第3図および第4図に示すようにハウジング9にベアリング10を介して回転可能に支持されている。ハウジング9はスライドベース11に一体に結合されていて、スライドベース11とともに砥石台12

を構成している。そして、砥石台12は送りモータ13とボールねじ14とにより送りが与えられて前進後退動作するようになっている。

砥石ホルダ8の外周にはチェーン sprocket 15が一体に形成されている一方、砥石ホルダ8側のチェーン sprocket 15と砥石駆動モータ16側のチェーン sprocket 17との間にはチェーン18が巻き掛けられていて、砥石7は砥石駆動モータ16によりチェーン18を介して回転駆動される。

したがって、ワークWと砥石7とを噛み合わせた上で、ワークWを主軸モータ6により、砥石7を砥石駆動モータ16によりそれぞれ同期回転させることによって、ワークWと砥石7とがあたかも歯車対の関係のようにして回転し、両者の歯面同士のすべり接触のためにワークW側の歯面に研削仕上加工が施される。

なお、主軸モータ6、送りモータ13および砥石駆動モータ16はそれぞれに位置検出器としてパルスジェネレータ19、20または21を有し

の歯の位相と砥石7側の歯の位相とが一致するように砥石7の歯を割り出す。これは、第3図および第4図に示すように磁気センサ25が砥石24と正対した位置で砥石駆動モータ16の回転を停止させることにより砥石7の歯が割り出される。

ワークWおよび砥石7の割り出しが完了したならば、送りモータ13を作動させて砥石台12に送りを与え、砥石台12を早送りにて所定量だけ前進させる。砥石台12を前進させるべきストロークは予め設定されており、しかも上記のようにワークWと砥石7との位相が既に一致していることから、これによってワークWと砥石7とがラフな状態で噛み合うことになる。

続いて、主軸モータ6に対して1パルスごとの回転指令を与えてワークWを微小量ずつ間欠的に回転させ、この動作を砥石7が回転し始めるまで続ける。つまり、ワークWの回転に併せて砥石7が連れ回りし始めるまでワークWを間欠的に回転させ、砥石7が連れ回りし始めた時点でワークWの回転を停止させる。

ており、各パルスジェネレータ19、20、21は位置決め制御装置22との間で位置フィードバックループを形成している。

砥石ホルダ8の側面には第3図および第4図に示すようにベアリングホルダ23を介して砥石24が取り付けられており、他方、ハウジング9には砥石24を被検出物として作動する磁気センサ25がブラケット26を介して取り付けられている。この磁気センサ25は、砥石24と正対している場合とそうでない場合とで磁界が変化する性質を利用して、その磁界変化を電流値の変化として出力するもので、砥石7を所定の定角停止位置に割り出す際に使用される。

このように構成された仕上加工装置を用いて加工を行う際には、第1図のフローチャートに示す手順による。

第1図および第2図に示すように、主軸モータ6によりワークWを回転させてワークWの歯が所定の位相となるように割り出す一方、砥石駆動モータ16により砥石7を回転させて、ワークW側

ここで、砥石7が連れ回りし始めたかどうかは、予め磁気センサ25と正対している砥石24が少しでも動くときこれを直ちに磁気センサ25が検知することで確認できる。

以上により、第5図にも示すようにワークWと砥石7の一方の歯面Fa、Fb同士が接触した状態が作り出され、この位置が基準位置となる。

基準位置が割り出されたならば、今度は主軸モータ6に対して1パルスごとの逆転指令を与えてワークWを微小量ずつ間欠的に逆転させる。そして、ワークWの逆転に併せて砥石7が連れ回りし始めるまでワークWを逆転させ、砥石7が連れ回りし始めた時点でワークWの回転を停止させる一方、その間のワークWの回転変位量を、主軸モータ6側のパルスジェネレータ19が発生するパルス数P₁としてカウントする。この回転変位量はワークWと砥石7との間のバックラッシュ量ΔC(第5図)に相当するものである。

なお、砥石7が連れ回りし始めたかどうかは上記と同様に磁気センサ25で検知される。

ワークWの回転変位量がパルス数 P_1 として得られたならば、次式によりバックラッシュ量 ΔC を算出する。

$$\Delta C = (\pi \cdot D_p / P_c) \times P_1$$

ここで、 P_c はワークWを1回転させたときの総割り出しパルス数、 D_p はワークピッチ円直径で、いずれも既知の値である。

上記のようにバックラッシュ量 ΔC の値が求められたならば、このバックラッシュ量 ΔC を零にするに必要な砥石台12の位置補正量 ΔZ 、すなわち第5図の状態においてあとどれだけ砥石7をワークWに近付ければよいかを次式によって求める。

$$\Delta Z = \Delta C / \tan \alpha$$

なお、 α は圧力角で、既知の値である。また、上記の一連の演算は位置決め制御装置22内の演算処理部で行われる。

砥石台12の位置補正量 ΔZ が求められたならば、この位置補正量 ΔZ を送りモータ13の制御系に付与して、砥石7を位置補正量 ΔZ だけさら

にワークWに近付ける。これにより、ワークWと砥石7との間のバックラッシュ ΔC が零となり、ワークWと砥石7とはバックラッシュのない適正な噛み合い状態となる。

こののち、位置決め制御装置22からの加工開始指令を受けて主軸モータ6および砥石駆動モータ16が作動し、以降は従来と同様にワークWと砥石7とがあたかも歯車対のように同期回転することで研削による仕上加工が施される。

なお、研削の際には必ずしもワークWを主軸モータ6で強制回転させる必要はない。

発明の効果

以上のように本発明によれば、加工開始に先立ち、被加工歯車と砥石とを噛み合わせた状態で被加工歯車を主軸モータにより正逆転させ、そのときのバックラッシュをセンサにより検出した上でそのバックラッシュ量に応じて砥石の位置を補正するようにしているので、従来と比べてバックラッシュ量を定量的に把握することができ、それによって高精度が要求される歯車の場合でも、加工

精度のばらつきをなくして加工精度そのものの向上と併せて加工精度の安定化を図ることができる。

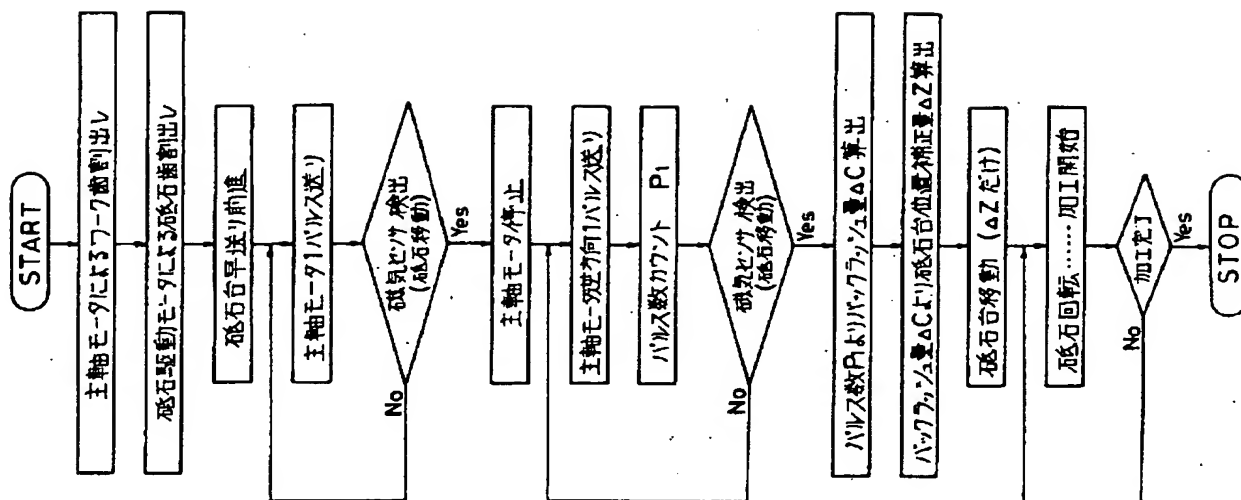
また、上記のようにバックラッシュ量を定量的に把握できることによってバックラッシュ量の確認のために作業者が関与する必要がなく、歯車の加工精度を維持しつつ歯車加工の完全自動化を実現できる。

4. 図面の簡単な説明

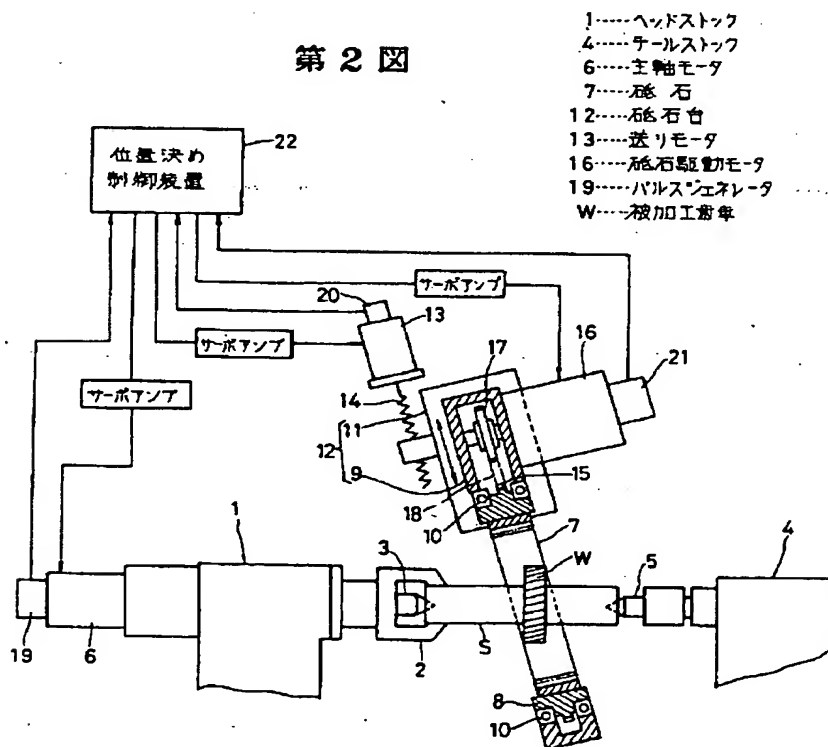
第1図は本発明の一実施例を示すフローチャート、第2図は本発明が適用される仕上加工装置の一例を示す構成説明図、第3図は第2図の砥石台の拡大断面図、第4図は第3図の右側面説明図、第5図は被加工歯車と砥石との噛み合い状態を示す説明図である。

1…ヘッドストック、3…ヘッドセンタ、4…テールストック、5…テールセンタ、6…主軸モータ、7…砥石、12…砥石台、13…送りモータ、16…砥石駆動モータ、19…パルスジェネレータ(センサ)、25…磁気センサ、W…被加工歯車、 ΔC …バックラッシュ。

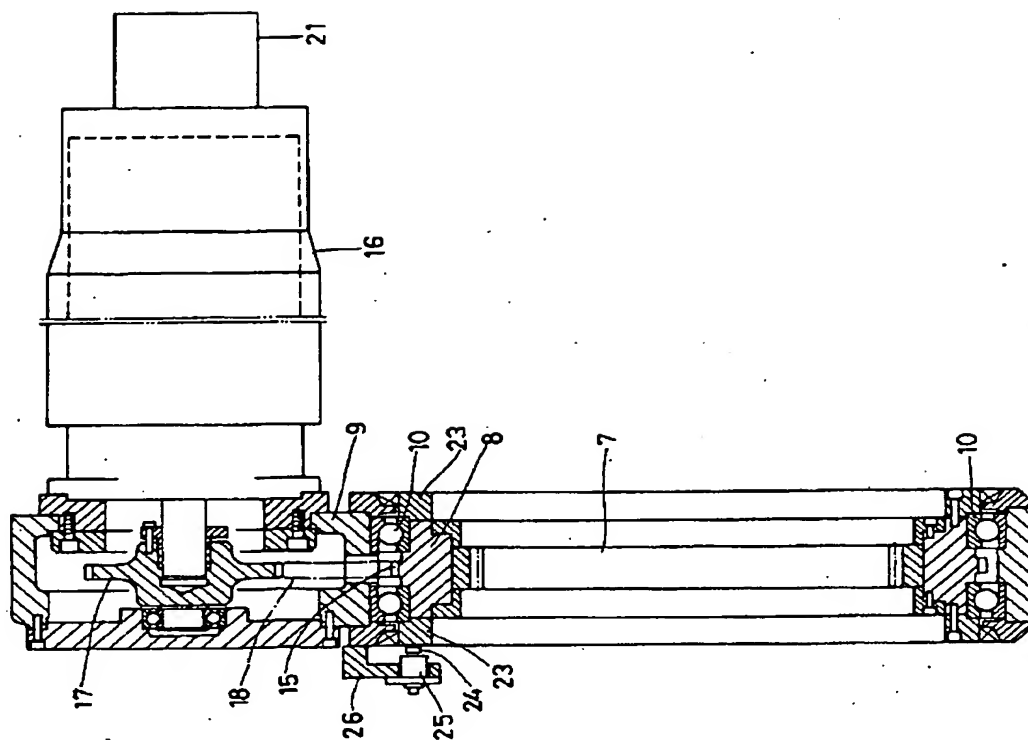
第1図



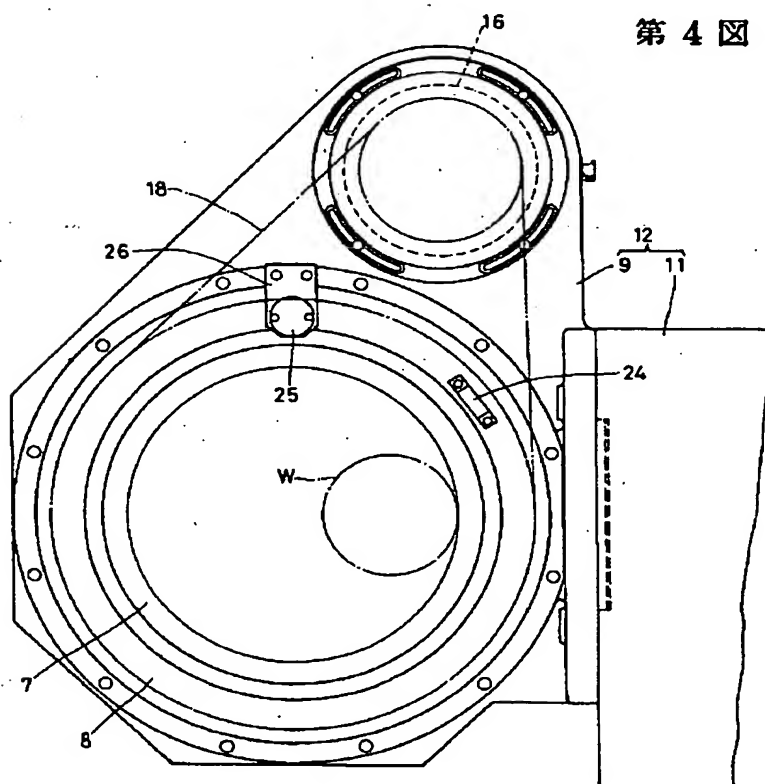
第2図



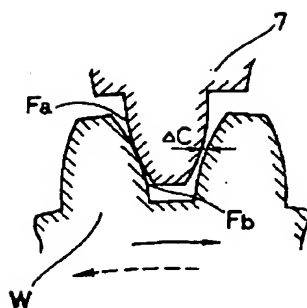
第3図



第4図



第5図



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